Palmer Station Antarctica LTER

The Palmer Antarctic (PAL) LTER program pursues a comprehensive understanding of the seasonal sea ice-influenced ecosystem south of the Antarctic Polar Front, including climate, plants, microbes, animals, biogeochemical processes, ocean, and sea ice. Since its establishment in 1990, the PAL LTER's central hypothesis has been that the seasonal and interannual variability of sea ice affects all levels of the Antarctic marine ecosystem, from the timing and magnitude of primary production to the breeding success and survival of penguins and whales. The site's location on the western side of the Antarctic peninsula (WAP) addresses multiple spatial and temporal scales. The goal of PAL LTER is to understand how long term change drives food web and biogeochemical dynamics in a region where the marine system is transitioning from polar to a subpolar.

Between 2008-2018:

17 investigators

11 institutions represented

48 graduate students

Marine

Principal Investigator:

Hugh Ducklow

Columbia University

Est. 1990

Funding Cycle:

LTER V

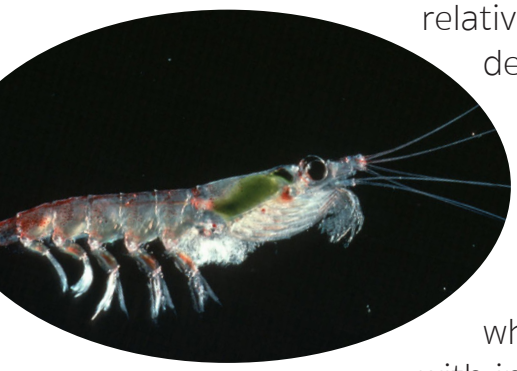
NSF Program:

Biological Sciences / Division of Environmental Biology

Key Findings

Keystone species ranges are changing. Shifts in sea ice are affecting the WAP ecosystem and biogeochemistry [Products 1, 2]. Despite dramatic shifts in Antarctic food webs [3, 4], the number of the keystone krill species (*Euphausia superba*) has not changed significantly over the PAL LTER study area [5]. However, researchers have observed reduced juvenile recruitment following positive anomalies of the Southern Annular Mode [6]. North of PAL LTER, *E. superba* population centers in the southwest Atlantic sector have been contracting southward for the past 90 years.

Ecosystem resilience. Between 2010 and 2017, the PAL LTER study area experienced cooler winter air temperatures, cooler summer surface ocean temperatures, and longer ice seasons relative to the first decade of the 21st century (but not relative to the 1950s-1970s). This has slowed sea ice declines, which is associated with increased primary productivity and ocean CO_2 drawdown [7, 8]. Springtime phytoplankton productivity and krill recruitment increased in years with high winter sea ice, which fed directly into penguin diets [6]. These processes are allowing researchers to assess the potential for food web recovery [1].



High trophic levels respond to West Antarctic Peninsula warming. Rapid warming in the WAP coincides with increases in gentoo penguin and decreases in Adélie penguin populations. While foraging ranges of Adélies and gentoos overlap with each other and with krill density maxima near Palmer Station, the vertical grazing ranges of the two penguin species differ [9]. This suggests that declines in Adélie penguin populations along the WAP are more likely due to direct (snowfall) and indirect (food web alterations) climate impacts on their life histories, rather than direct competition for food [10].

Do whales and penguins compete? Humpback whale populations are growing at their biological maximum as they recover from intense commercial whaling. New cetacean research at PAL LTER shows that humpbacks forage in close proximity to the penguins near Palmer Station, and in similar portions of the water column used by Adélie penguins during critical chick rearing periods [9]. Palmer LTER researchers plan to quantitatively assess whether this observation is an indication of competition between baleen whales and penguins.

Climate forcing of the West Antarctic Peninsula. Over the past five decades, the West Antarctic Peninsula (WAP) has experienced changes related to rapidly warming winter atmospheric temperatures, dramatic sea ice declines, and accelerated glacial melting. Interactions between ocean and atmospheric climate cycles (El Niño, Southern Annual Mode) influence shoreward heat delivery associated with deep warm ocean waters and alter the upper mixed ocean layer, productivity at the base of the food web, and carbon cycling on the continental shelves. [1, 4, 7]

Synthesis

Cross-site synthesis project with McMurdo Dry Valleys (MCM) LTER. In 2016, three joint papers in BioScience identified common ecological responses to physical forcing in PAL and MCM LTER, two highly disparate Antarctic ecosystems.

Coordinated sampling with colleagues in the British Antarctic Survey. Joint and coordinated sampling since the mid-1990s has resulted in complementary time series sampling at Palmer and Rothera stations and regional sampling along the WAP. Palmer LTER researchers helped organize an international workshop in 2018 that resulted in a special issue of Philosophical Transactions of the Royal Society that focused on WAP physical, chemical, and biological dynamics.

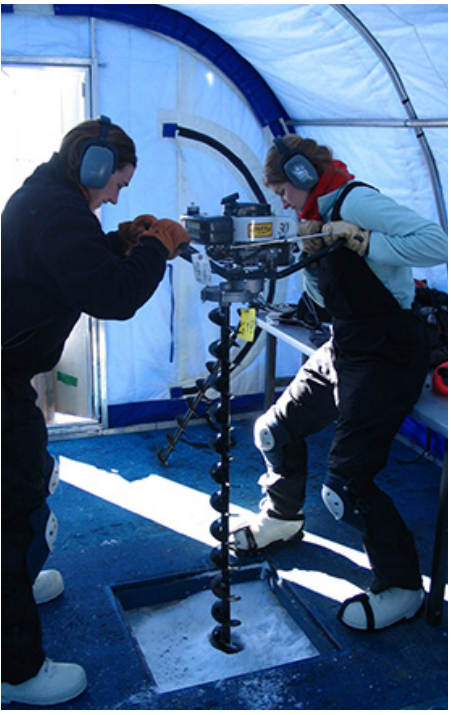
Data Accessibility

All Palmer Station and WAP data collected over the past 26 years is maintained in the PAL LTER data archive and posted to the Environmental Data Initiative (EDI) repository, regardless of the funding source. Easy access to these datasets has proven invaluable, especially for collaborations and synthesis studies.

Partnerships

NSF Office of Polar Programs | NOAA | NASA | Gordon & Betty Moore Foundation | G. Unger Vetelsen Foundation

Broader Impacts



Professional development for teachers. Almost 7,000 middle and high school students participated in a year-long program with the PAL LTER. Seventy-five educators participated in a week-long professional development program (Sci-I) that focused on encorporating PAL LTER data into teaching. The Sci-I program culminated in a student research symposium at Rutgers University.

Classroom video calls. Palmer LTER scientists and graduate students worked with the education and outreach team to offer live video teleconference calls (VTCs) between Palmer Station and U.S. classrooms. During the 2017 field season, for example, PAL LTER reached 23 educators and approximately 1,725 students from 5 states (NY, NJ, CA, NC, MA) in grades 5-12.

***You're the Expert* Podcast.** National Public Radio (NPR) shared PAL LTER research stories on their *You're the Expert* program. Approximately 300 students, faculty, and staff from Rutgers University attended the taping of the show and NPR reports 250,000 downloads to date.

Palmer Station at the movies. With NSF support, the PAL LTER team produced a full length documentary on Palmer Station research entitled *Antarctic Edge: 70 Degrees South*. Undergraduate music and art students from Rutgers University collaborated with researchers to edit and develop a musical score for the film, which was broadcast at theaters across the U.S. and was available for download on iTunes.

Top Products

1. Schofield, O et al. 2018. Changes in upper ocean mixed layer and phytoplankton productivity along the West Antarctic Peninsula. **Philosophical Transactions of the Royal Society.** doi 10.1098/rsta.2017.0173
2. Bowman, JS et al. 2018. Recurrent seascape units identify key ecological processes along the western Antarctic Peninsula. **Global Change Biology.** doi: 10.1111/gcb.14161
3. Montes-Hugo, M et al. 2009. Recent changes in phytoplankton communities associated with rapid regional climate change along the Western Antarctic Peninsula. **Science.** doi: 10.1126/science.1164533
4. Sailley, S et al. 2013. Carbon fluxes and pelagic ecosystem dynam¬ics around the West Antarctic Peninsula Adélie penguin colonies: An inverse model analysis. **Marine Ecology Progress Series.** doi: 10.3354/MEPS10534
5. Steinberg, DM et al. 2015. Long-term (1993-2013) changes in macro-zooplankton off the Western Antarctic Peninsula. **Deep Sea Research II.** doi: 10.1016/j.dsr.2015.02.009
6. Saba, GK et al. 2014. Winter and spring controls on the summer food web of the coastal West Antarctic Peninsula. **Nature Communications.** doi: 10.1038/ncomms5318
7. Brown, MS et al. 2019. Enhanced oceanic CO_2 uptake along the rapidly changing West Antarctic Peninsula. **Nature Climate Change.** doi: 10.1038/s41558-019-0552-3
8. Stukel, MR. et al. 2015. The Imbalance of New and Export Production in the Western Antarctic Peninsula, a Potentially "Leaky" Ecosystem. **Global Biogeochemical Cycles.** doi: 10.1002/2015GB005211
9. Cimino, MA et al. 2016. Climate-driven sympatry may not lead to foraging competition between congeneric top-predators. **Scientific Reports.** doi: 10.1038/srep18820
10. Cimino, MA et al. 2019. The interaction between island geomorpholgy and environmental parameters drives Adélie penguin breeding phenology on neighboring islands near Palmer Station, Antarctica. **Ecology and Evolution.** doi: 10.1002/ece3.5481

Photo credits: PAL LTER & U.S. LTER